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KOLESOV, SOVIET LATHE OPERATOR, DEVELOPS NEW TOOL FOR POWER CUTTING

/The following report was compiled from information in various Soviet newspapers on a new type of cutting tool developed by V. A. Kolesov, a lathe operator at the Kuybyshev Srednevolzhskiy Machine Tool Building Plant.

Two articles on this subject published in Izvestiya, 7 and 18 February 1953, have already been translated in The Current Digest of the Soviet Press, Volume V, Number 7, 28 March 1953, page 27, under the heading Industry and entitled "Victory of a Bold Thought." The information covered in the Digest will not be duplicated in this report. However, attention is called to certain differences in terminology at variance with FDD usage. For example, in FDD usage, Vsesoyuznyy Nauchno-Issledovatel'skiy Instrumental'nyy Institut is translated as All-Union Scientific Research Tool Institute rather than All-Soviet Instrument Research Institute, and the ENIMS is expanded as Experimental Scientific Research Institute of Metal-Cutting Machine Tools rather than Metal-Cutting Tool Experimental Research Institute. The last line of the Digest report gives "designs of cutting tools for deeper cutting." The FDD translation would be "designs of cutting tools with larger feeds."

A glossary on cutting-tool nomenclature is appended. Numbers in parentheses refer to appended sources./

B. Sak-Shak, candidate of technical sciences and director of the Department of Machine Building Technology of the Latvian State University, writing in Sovetskaya Latviya, 18 January 1953, states that the extensive introduction of high-speed cutting has effected a considerable increase in labor productivity in the metalworking industry. Using hard-alloy and ceramic cutting tools developed by Soviet engineers and scientists, well-known lathe operators such as Bortkevich, Dikov, Kulagin, Bykov, Bushuyev, etc., have achieved high speeds in machining metal, Sak-Shak states.

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To meet the requirements of Stakhanovites, he says, Soviet designers have developed outstanding high-speed machine tools in which the spindle speed reaches 6,000 revolutions per minute. Even small-diameter parts can be machined on these machine tools at high speeds. Edmund Damberg, a Riga lathe operator who operates a lathe produced by the Moscow Krasnyy Proletariy Plant, achieved the record speed of 4,437 meters per minute with the use of ceramic cutting tools. [redacted] for a description of his experience.]

However, Sak-Shak continues, a large number of old-design machine tools which are incapable of generating high spindle speeds are still being used in industry. These machine tools have been adapted for high-speed methods by being equipped with more powerful electric motors.

According to Sak-Shak, a method of increasing labor productivity other than by increasing the cutting speed has been developed by Vasiliy Kolesov, a lathe operator at the Kuybyshev Srednevolgzhskiy Machine Tool Building Plant. This method is now known as the power method of cutting. [redacted]

Operating at high speeds, lathe operators usually feed the tool along the workpiece at a rate of 0.25-0.5 millimeter per revolution. By increasing the feed to 3-5 millimeters, it is possible to increase labor productivity rapidly and at comparatively low cutting speeds. Sak-Shak concludes that Kolesov's reasoning is that the number of meters of chips cut per minute does not matter so much as the number of parts machined.(1)

In an article published in Trud, 11 January 1953, Kolesov explains his power method of cutting and emphasizes certain points which provoked lengthy discussions in subsequent publications. These explanations and discussions are reported below.

In describing his method, Kolesov says he manufactured a cutting tool which appeared to answer all requirements and produced a mirror-like finish on the parts machined. However, he said, it was unsatisfactory because the chip did not curl but took on a straight wire-like form.

With the aid of I. Yakovlev, the plant's chief engineer, L. Katkova and A. Kashayeva, engineer-techologists, he finally solved this problem. Thus, he said, parts could be finish-machined with a feed of from one to 3 millimeters, or in other words, 4 to 12 times as fast as formerly. Kolesov states that the cutting speed of his DIP-300 lathe reached 150 meters per minute. Depending on the machine tool, the feed can be increased to 4 or even 5 millimeters with the use of the new tool.

According to Kolesov, his cutting tool differs from ordinary turning tools by a wider [end] cutting edge which is 3.5 millimeters wide. It is located parallel to the axis of the workpiece. The chip breaker is not parallel to the side cutting edge but is at an angle of 15-20 degrees and has a rake of 3 degrees. The tool has T15K6 hard-alloy tips.

Kolesov claims that any skilled lathe operator can manufacture such a cutting tool and that it can be used on any lathe with a motor of sufficient power.

He goes on to say that he has demonstrated his cutting tool at many plants, the first of which was the Chkalov Machine Tool Building Plant. Using a lathe more powerful than his DIP-300, he successfully machined a steel part in 6 instead of 200 seconds and the part had the required surface finish and accuracy.

Kolesov states that he demonstrated his cutting tools just as successfully at the Syzran' Hydroturbine and Combine Plants and at a machinery repair plant of the Kuybyshevgidrostroy. He introduced the new tool at the Moscow Krasnyy Proletariy Plant and the Plant imeni Ordzhonikidze. At every enterprise where the new tool was demonstrated, he says it received complete and unconditional recognition.(2)

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Moskovskaya Pravda, 22 March 1953, reports that during his stay in Moscow, Kolesov spoke at the Institute of Machine Studies of the Academy of Sciences USSR, at the Higher Technical School imeni Bauman, at the Polytechnic Museum, at large-scale enterprises, and at a number of scientific research institutes. The article states that the new method has been highly rated and enthusiastically supported.(3)

In Kolesov's article of 11 January 1953, he tells about giving lectures on the power method of cutting at the Scientific Council of the Institute of Machine Studies of the Academy of Sciences USSR, and at three departments of the Moscow Technological Institute of Light Industry imeni Kaganovich. As a result of these lectures, an intensive study of power methods of cutting has been started by a group of scientists who are considered specialists in cutting problems.

Kolesov points out that the power method of cutting is not yet perfected. Its potentials are a long way from being fully exploited, he states. For example, he concludes, a single method of combining high-speed and power cutting can be worked out; and gang mills can be manufactured on the principle of increased feeds.(2)

The main trend in the further development of high-speed metal-working, writes I. Kapustin, professor and doctor of technical sciences, in Trud, 18 January 1953, must be directed toward the unification and complex utilization of achievements made by Bykov, Bortkevich, Kolesov, and other innovators. In this way, much greater productivity can be achieved than by utilizing each method separately. For example, Kapustin states, to machine in two passes a shaft 1,200 millimeters long and 100 millimeters in diameter at a speed of 200 spindle revolutions per minute with a feed of 0.25 millimeter per revolution, the cycle time would take 48 minutes. If the roughing and finishing passes were combined, the speed of cutting increased to 400 meters per minute, and the feed brought to 3 millimeters per revolution, the cycle time would be approximately 0.3 minute; that is, it would be decreased 160 times.(4)

Following Kolesov's report at the Scientific Council, P. Shari wrote in Trud, 31 January 1953, that the Commission for Technology of the Institute of Machine Studies, Academy of Sciences USSR, headed by V. I. Dikushin, corresponding member of the academy, began to study the method of power cutting. The scientists have set before themselves the task of combining high-speed and power cutting.

At present, Shari notes, the experience of working according to Kolesov's method is being repeated at the Moscow Automobile Plant imeni Stalin. In the near future, the Commission for Technology will study the problems of machining parts with large feeds at a number of other Moscow enterprises.

Shari goes on to say that the Commission for Technology, created for coordinating scientific research and for publicizing progressive methods and introducing them into industry, is strengthening its ties with industrial enterprises and with production innovators. It is combining into eight sections more than 400 scientific workers engineers of various plants, Stakhanovites, and innovators. Shari concludes that P. B. Bykov, a lathe operator at the Moscow Grinding Machine Plant, for example, is a member of the commission, whose staff includes such well-known scientists as Ye. A. Chudakov, I. P. Bardin, I. I. Artobolevskiy, and V. P. Nikitin, academicians.(5)

In another statement in his article of 11 January 1953, Kolesov points out that it is difficult to understand why the Ministry of Machine Tool Building USSR is reticent about introducing the new method. The same attitude prevails at the Central Committee of the Trade Union of Workers of the Machine Tool and Tool Industry, he notes.(2)

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In reference to Kolesov's article, D. Ryzhkov, Deputy Minister of Machine Tool Building, has made the following comments, published in Trud, 11 February 1953:

Ryzhkov points out that Kolesov's method can find wide application in semi-finishing such parts as shafts, gears, bushings, flanges, etc., depending on the condition and capacity of the lathe.

The Ministry of Machine Tool Building has taken measures to popularize Kolesov's method. The Central Bureau of Technical Information of the ministry has prepared and published a poster and brief instructions with drawings of the cutting tool and a description of Kolesov's method of operation. It has suggested that plants manufacture a batch of the cutting tools and begin to use them on machine tools equipped for coarse feeds.

It would be erroneous to divorce Kolesov's method from high-speed metal cutting. An increase in labor productivity in machining metal depends equally on two factors, feed and cutting speed. The combination of the maximum, technologically permissible feeds and cutting speeds commensurate with the established life of the cutting tool gives best results.

The wide application of increased feeds and Kolesov's cutting tools will require minor modernization of the existing lathe park. The ministry has ordered plants to formulate charts for modernizing their equipment and to do work on converting lathes to increased feeds if they were not originally built for coarse feeds. Of particular importance is the training of workers to master the new method. High-speed lathe operators are being sent to the Srednevolzhskiy Machine Tool Plant to study Kolesov's method. Later, they will act as instructors for short-term courses at plants.

For further study and publicizing of Kolesov's method, scientific research organizations of the Ministry of Machine Tool Building must in a very short time, as directed by the ministry, conduct tests of Kolesov's cutting tools in machining steel and cast iron, and develop and present practical recommendations for utilizing this method at various plants of the ministry.

The ENIMS, in the near future, must work out and release manuals on modernizing lathes for operating with coarse feeds. Further, the scientific research institutes must send their associates to study at the Srednevolzhskiy and other machine tool building plants.(6)

Moskovskaya Pravda, 22 March 1953, contains an article concerning a meeting of scientific, engineering, and technical workers of Moscow and Moskovskaya Oblast on 20 March. P. Grudlov, candidate of technical sciences and head of the Metal-Cutting Laboratory of the All-Union Scientific Research Tool Institute, and A. Prokopovich, chief engineer of the ENIMS, told about the work of the institutes concerning the study and perfection of V. Kolesov's method.

Comparative studies of ordinary cutting tools and Kolesov's cutting tool showed the advantages of the new tool, Grudlov and Prokopovich noted. It has made it possible to shorten the cycle time from two to ten times.

They went on to say that experimental work with coarse feeds showed the possibility of converting to the new method not only lathes but also milling, drilling, boring, and other metal-cutting machine tools.

At the All-Union Scientific Research Tool Institute, a special hob for cutting gears with increased feeds has been developed, they continued. With the use of a high-speed steel hob, cycle time was shortened four to five times. The use of hard-alloy cutters was even more effective.

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Grudlov and Pokopovich also stated that workers at the ENIMS were able to modernize 15 different machine tools at little cost. As a result, they said, the range of feeds on machine tools increased 1.2 to 2 times. Devices for automatic disengagement of feed on lathes were developed. This will make it possible to broaden considerably the products list of parts that can be machined by the new method, they concluded.(3)

Ye. Nadeinskaya, director of the All-Union Scientific Research Tool Institute, reported in Komsomol'skaya Pravda, 31 March 1953, that Kolesov's cutting tools have been tested at the cutting laboratory of that institute. On the basis of tests made, the institute has worked out instructions for correctly utilizing these cutting tools to achieve best results, Nadeinskaya stated.

The material recommended for the cutting parts of the tool are hard alloys T5K10, T14K8, and T15K6. Alloy T5K10 must be used with a depth of cut of 2-4 millimeters, and a feed of 3 millimeters or more per workpiece revolution. Alloys T15K6 and T14K8 must be used with a depth of cut of from 0.5 to 2.5 millimeter and feeds of from 0.5 to 3 millimeters. The instructions include a detailed table for cutting speeds depending on the depth of cut and feeds used. The force of cutting as well as the power of the machine tool required in each instance has been calculated.

However, Nadeinskaya emphasizes that simply to manufacture cutting tools of Kolesov's design is a long way from mastering his method. The lathe operator must make sure that the machine tool is in fit condition and that the vibration and play of the spindle, slide, and table have been eliminated. In many cases, the machine tool must be modernized, the power of the drive must be increased, belt drive replaced by V-belts, and the friction clutch strengthened. Finally, automatic disengagement of feed in machining graduated shafts must be provided to prevent tool, part, or machine-tool breakage.(7)

An article published in Tekhnika-Molodezhi, May 1953, written by G. A. Shaumyan, Stalin Prize winner and doctor of technical sciences, states that ceramic cutting tools can also be used in operating by Kolesov's method with increased feeds. Shaumyan stated that experiments have confirmed that these cutting tools can machine steel with feeds up to 3.5 millimeters /per spindle revolution/.(8)

Kolesov's final point in his article of 11 January 1953 stressed that the discrepancy between cycle time and handling time must be eliminated. Although some advancement has been made in this direction, a great deal still remains to be done he said.(2)

In this connection, B. Sak-Shak commented in his article of 18 January 1953 as follows: It is very important for each enterprise to study seriously the problem of shortening handling time. At present, machine tool operators spend one half to three quarters of the total time on secondary operations in machining a given part. This situation, of course, lowers the effectiveness of high-speed and power cutting. As can be observed from V. Kolesov's work, the cycle time for machining a part was shortened 33 times, whereas labor productivity was increased only six or seven times.

To utilize fully the advantages of the new method, manual operations of the machine-tool operator must be mechanized and handling time must be brought to a minimum. The quick-acting attachments and accessories which have already been developed must be disseminated more extensively.(1)

In response to the many requests for additional information on Kolesov's new cutting tool and method as described in Trud, 11 January 1953, the following sketch and description, published in Trud, 18 January 1953, have been prepared by I. Kapustin, professor, doctor of technical sciences.

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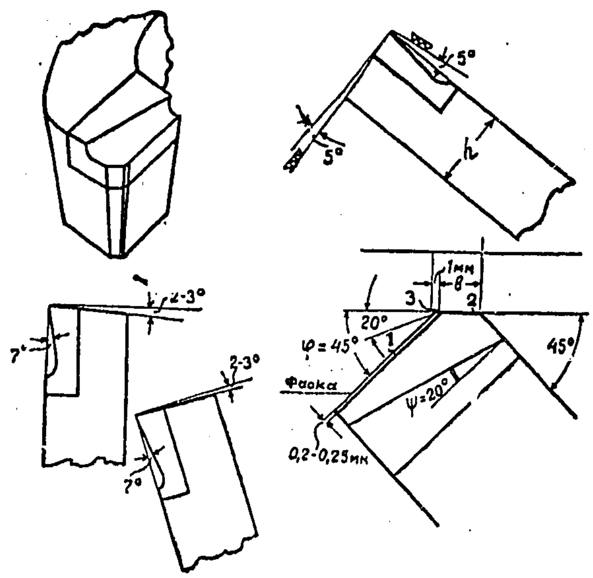

Kolesov's tool has two cutting edges. The inclined side-cutting edge, 1, cuts into the workpiece and removes the primary layer of metal. An end-cutting edge, 2, located parallel to the axis of the workpiece, removes the portion of metal remaining in the form of crests, ridges, and other irregularities. The width, B, of the cutting edge, 2, must be 0.3-0.5 millimeter greater than the feed. In practice, this ratio makes the work with large feeds more accurate.

To ease the tool into the metal, Kolesov added an intermediate cutting edge /nose/, 3, which connects edges 1 and 2 and protects the tip of the cutting tool from chipping. This edge is only one millimeter wide and is disposed at a 20-degree angle to the axis of the workpiece. The cutting edges of the tool are honed (with an abrasive hone) to a flat 0.2-0.25 millimeter wide with a negative rake of 2-5 degrees.

The chip breaker on the face of the tool is 8-10 millimeters wide and one to 1.5 millimeters deep. The groove of the chip breaker is disposed at a 15-20 degree angle to the side cutting edge, 1. The plane of the chip breaker groove slopes toward the point of the tool. The side cutting edge, 1, must slope down from the point of the tool at an angle of one to 2 degrees. The normal side rake

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of the tool is positive and equal to 5-7 degrees; the normal end relief and nose relief (of 2 and 3) are 2-3 degrees; and the normal side relief (of 1), 5 degrees.

Kolesov's cutting tools have tips made of hard tungsten-titanium-cobalt alloys, for example, T15K6. The tool is ground after being joined to the shank. All its surfaces must be lapped with a paste containing boron carbide. Cutting edge 2 and its relief must be finished very carefully because the quality of the surface finish of the part depends on this edge to a considerable degree.

To ensure that no ridges remain on the work surface, the tool must be mounted in the tool post in such a way that the cutting edge 2, is parallel to the axis of the workpiece. In relation to the height of centers of the machine tool, the tool must be set in such a way that its point is 0.02 diameter of the workpiece below the centers. For quiet, vibrationless machining, the overhang of the tool must be approximately equal to its height. At the same time, it must be remembered that the vibration of the tool and the machine tool also depends on the speed, depth of cut, feed, rigidity of the machine tool, etc.

In grinding and setting the tool, consideration must also be given to the disposition of the chip breaker. With proper disposition of the tool and chip breaker, the chip, impinging on the face of the tool, will curl, strike the non-machined surface of the workpiece and break, falling into small rings. If the chip breaker is not properly disposed, and its rake is very great, the chip will strike against the finished surface and will scratch and scare it.

The parallel back rake also influences the peeling off and direction of the chip. It is important for this rake not to exceed 3 degrees. With a negative rake, the chip will take on the form of a continuous spiral, which will hamper the work of the operator.

In mastering Kolesov's method, lathe operators must remember that with coarse feeds and deep cuts, the force of cutting increases. Therefore, secure clamping of the workpiece on the machine tool is mandatory. To prevent the dislodgment of the workpiece deep into the chuck, it is recommended that a supporting arbor with a tapered shank be inserted in the tapered hole of the spindle. The workpiece being held in the chuck must rest against this arbor. Prior to clamping the workpiece in the chuck, the tailstock center must be pressed against it tightly.

To apply the new method successfully, it is important that the machine tool be in good working order. The bolts and bearings must be tightened and adjusted, the transmission checked, the machine tool carefully lubricated, the tailstock firmly secured, the capacity of the machine tool checked, etc. Proper care of a machine tool will prolong its life and maintain its efficiency. Kolesov has operated the same DIP-300 for 9 years, and during the last 4 years, he has been using feeds of about 3 millimeters. During this time, the machine has not undergone capital repair.

In machining a part with coarse feeds, it is absolutely essential to use a live tailstock center. With a dead tailstock center, the surface of its contact with the part collapses and this affects the machining accuracy.

In each case, the machining conditions must be selected in respect to the design, length, diameter, and material of the part, the accuracy of its manufacture, power of the machine tool, its condition, quality of the cutting tool, etc.

Experience has shown that if proper conditions are maintained, an increase in feed does not bring about any difficulties.(4)

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Additional descriptive information on Kolesov's method and tool is contained in Ye. Nadeinskaya's article of 31 March 1953, as follows:

Using his own cutting tool, Kolesov machined a part 64 millimeters in diameter for the Model 1616 machine tool, with a depth of cut of 1.7-2 millimeters and spindle speed of 800 rpm, that is, with a cutting speed of approximately 150 meters per minute. He used a feed of 2.7 millimeters per revolution of the workpiece.

In Nadeinskaya's description of Kolesov's cutting tool, she mentions that the length of the end cutting edge (edge 2) must be 0.15-0.30 millimeter greater than the feed. To assure the proper peeling of chips into small coils 20-30 millimeters in diameter, a recess has been made on the face of the tool, one side of which slopes toward the axis of the part at an angle of 30 degrees, and the other side of which is parallel to the cutting edge. Recently, Kolesov has been using clamped-on or brazed-on chip breakers.(7)

/It is probable that the cutting elements of Kolesov's tool have been changed in the course of its evolution. This may explain certain discrepancies in this report. For example, Nadeinskaya specifies that the end cutting edge must be 0.15-0.30 millimeter greater than the feed; whereas, Kapustin describes this edge as being 0.3-0.5 millimeter greater than the feed./

Sovetskaya Kirgiziya, 9 April 1953, reported on a lecture given by A. K. Kim, an engineer at the Frunze Agricultural Machine Building Plant imeni Frunze, on Kolesov's method of power cutting to an assembly of lathe operators and engineering and technical workers. One question asked at the conclusion of his lecture referred to the method of finishing the cutting tool if no lapping machine is available. He answered that the lapping device consists of one part, a cast-iron disk with a boss. The disk is 150-200 millimeters in diameter. The boss is clamped in the chuck of the lathe.

The face of the disk is covered with a paste composed of 60 percent boron carbide and 40 percent paraffine by weight. The tool is finished in the following manner: It is clamped in the tool holder in the proper position and carried by the tool slide to the paste-covered disk. Rotating at a speed within the range of 0.8-1.5 meters per minute, the disk laps the edges of the tool to the required surface finish.

Another question asked of Kim concerned the reason for mounting the tool .02 of the diameter of the workpiece below the centers. Kim explained that the relief of Kolesov's tool is small, and stopping it exactly on center would cause considerable friction between the flank of the tool and the machined surface of the part. This causes rapid wear of the tool flank and vibration of the workpiece.

He was then asked why the relief of Kolesov's tool is so much smaller than that of conventional tools. The reason, said Kim, is that this cutting tool must withstand greater stresses than an ordinary tool. Therefore, the relief has been made small, thereby increasing the strength of the cutting tool.(9)

Examples of application of Kolesov's method at various enterprises, taken from three Moscow newspapers, are cited below.

The power method of cutting metal, developed by V. Kolesov is being extensively adopted at machine building enterprises in Sverdlovsk. Samples of the new tool, ground according to Kolesov's method, were manufactured at the cutting laboratory of the /Sverdlovsk/ Turbomotor Plant. Tests showed excellent results. Special instructions have been issued to shops, and the centralized grinding of cutters has been organized.(10)

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The new power method of metal cutting has been mastered by two thirds of all workers at the Srednevolzhskiy Machine Tool Building Plant where Vasiliy Kolesov is employed.(11)

Lathes have been repaired and cutting tools manufactured at the Moscow No 14 Trade School of Metalworkers in accordance with blueprints developed by Kolesov. The first experiments showed good results.

Preparations are now being made at the school to convert many machine tools to power metal cutting. Trainees are studying Kolesov's methods of operation and, in particular, the technique of manufacturing tools of his design.(12)

Kolesov's methods are being adopted far and wide. At the Sverdlovsk Uralmash Plant, more than 300 men studied and applied this new method. A large batch of tools was manufactured. In the process of manufacturing these tools, the Uralmash workers made certain changes and improvements in the tool which made it possible for them to reduce the expenditure of hard alloys.(13)

GLOSSARY OF CUTTING-TOOL NOMENCLATURE (14)

Transliteration of Russian	Definition	English Equivalent
Perednyaya poverkhnost'	The surface on which the chip impinges	Face
Zadnyaya poverkhnost'	The surface which faces the machined workpiece	Flank
Glavnaya rezhushchaya kromka	The edge which cuts the larger part of the perimeter length of the chip cross section	Side cutting edge
Vspomogatel'naya rezhushchaya kromka	The edge which cuts the smaller portion of the length of this perimeter	End cutting edge
Perekhodnaya rezhushchaya kromka	The edge which joins the side and end cutting edges	Nose
Ploskost' rezaniya	A plane tangent to the cutting surface and passing through the straight cutting edge	Cutting plane
Osnovnaya ploskost'	A plane parallel to the longitudinal and cross feeds. In turning and planing tools with a prismatic body, this plane is the bottom supporting surface of the cutter.	Base (basic plane)
Glavnyy zadnyy ugol	The angle between the flank of the tool and the cutting plane	(Normal) side relief angle
Ugol zaostreniya	The angle between the face and flank of the tool	Included angle

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Transliteration of Russian	Definition	English Equivalent
Perednyy ugol	The angle between the face of the tool and a plane normal to the cutting plane, drawn through the side cutting edge	(Normal) side rake
Glavny ugol v plane	The angle between the projection of the side cutting edge on the basic plane and the direction of feed	Side cutting edge angle
Vspomogatel'nyy ugol v plane	The angle between the projection of the end cutting edge on the basic plane and direction of feed	End cutting edge angle
Ugol pri vershine v plane	The angle between the projection of the cutting edges on the basic plane	Nose angle
Ugol naklona glavnoy rezhuschey kromki	The angle included between the cutting edge and a line, passing through the point of the cutter parallel to the basic plane	(Parallel) back rake

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